NO_2 ドープダイヤモンド MOS 構造の C-V 測定と界面特性解析

C-V Measurements and Interfacial Property Analysis of NO_2 Hole Doped Diamond MOS Structure

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1.Introduction

Diamond is the best electronic material for the high-power operation due to its high band-gap (5.47 eV) and high break down field (>10 $MVcm^{-1}$). NO_2 hole doping increase surface concentration [1] and Al_2O_3 passivates the hole channel [2]. However, the mechanisms of hole doping and Al_2O_3/diamond interface are not clearly understood. In this work, we fabricate diamond MOS structures with and without NO_2 hole doping and analyze the interface properties in order to investigate NO_2 hole doping effect.

2. Fabrication Process

Diamond MOS diodes with NO_2 hole doping consist of Al gate metal, atomic-layer-deposited (ALD) 32-nm-thick Al_2O_3, and 1-µm-thick (001) H-diamond homoepitaxial layer, as shown in Fig.1. Another MOS diode was fabricated similarly except NO_2 exposure.

3. Experimental Results

Capacitance-voltage (C-V) characteristics of MOS structures with and without NO_2 hole doping are showing in Fig.2. Measurements were performed at room temperature in dark. Sheet carrier concentration of MOS diode with NO_2 hole doping was calculated to be 1.73 x 10^{13} cm^{-2}, which is four times higher than 4.5 x 10^{12} cm^{-2} of the diodes without NO_2 hole doping. C-V hysteresis were 0.27 V and 0.68 V for MOS diodes without and with NO_2 hole doping, respectively. High hole carrier concentration of NO_2 hole doped MOS requires high voltage to deplete carriers and shifted its C-V curve to the positive gate voltage side by ~4 V. We speculated that higher density of holes may be trapped at the interface, which results in higher C-V hysteresis for NO_2 hole doped MOS diode.

4.Conclusion

We fabricated and compared diamond MOS didoes with and with NO_2 hole doping. Sheet carrier concentration and interface state density were higher in NO_2 hole doped MOS structure.

Acknowledgements

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References

[1] M. Kubovic and M. Kasu, Appl. Phys. Express 2 (2009) 086502.
[2] M. Kasu et al., Appl. Phys. Express 5 (2012) 025701.

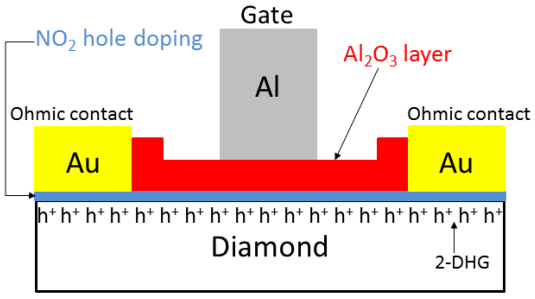

Fig.1 Schematic cross section of NO_2 hole doped diamond MOS diode.

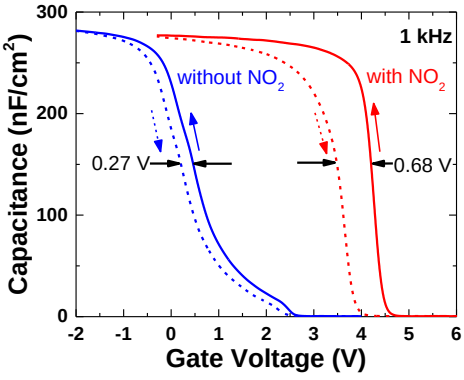

Fig. 2 C-V characteristics of MOS diodes without (blue) and with NO_2 hole doping (red).